Massachusetts RPS: 2002 Cost Analysis Update – Sensitivity Analysis

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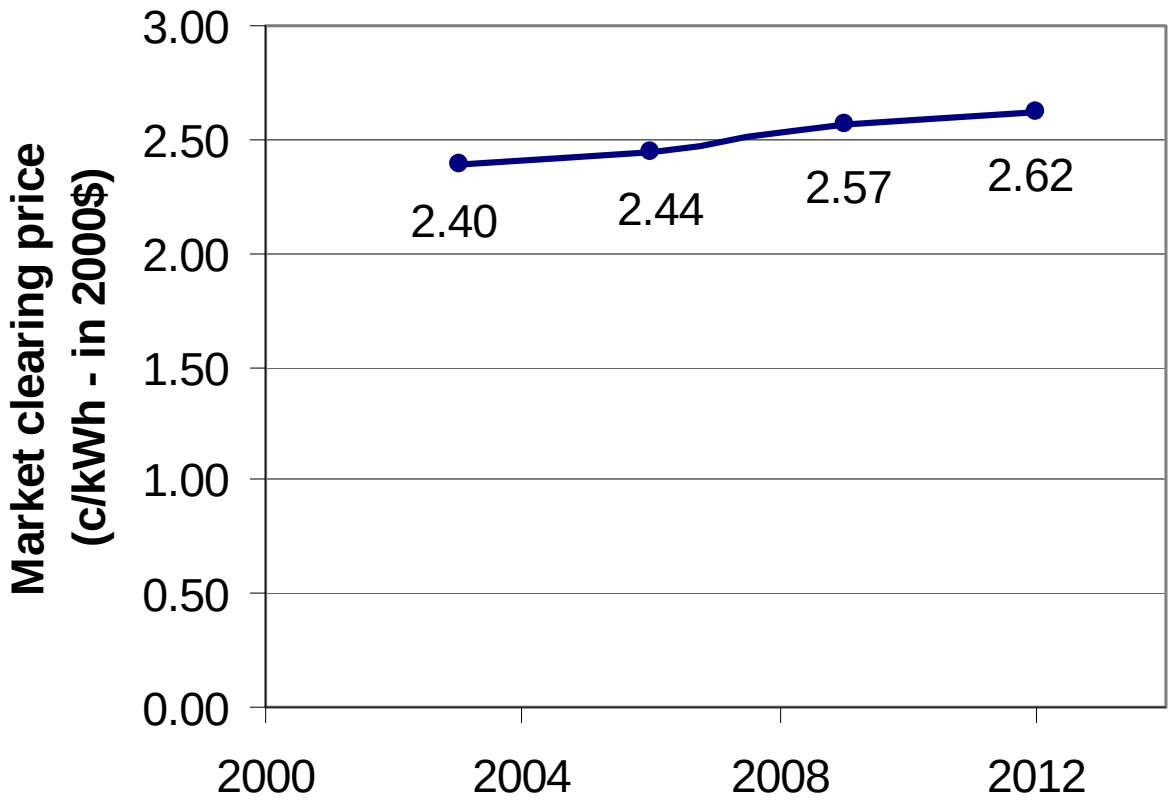
Overview

- Analysis Goals & Limitations
- Updated Base Case Results
- Scenarios – High and Low RPS Cost
- Major Cost Drivers
- Implied Supply Mix
- Import Cost Analysis
- Conclusions

Goals of Analysis

- Update to December 2000 Report
  - Capture market conditions, reflect final RPS rule
- Analysis of New Renewables Requirement
  - Incremental new renewable energy generated
  - Which technologies contribute, when
  - Forecast “market clearing prices” for RPS-eligible certificates
- What the Analysis is:
  - A ballpark bounding analysis of costs and impacts
- What the Analysis is not:
  - Full-blown cost-benefit analysis
  - An attempt to capture short-term volatility

December 2000 Results - Forecast of Market Clearing Prices for RPS-eligible Certificates



Analysis Limitations

- Examine Market, as it Exists Today
- Renewable Tech. Costs Difficult to Capture
  - Technological advance difficult to project
  - Little development experience in the Northeast
  - State and Federal support could decrease costs
  - Biomass fuel supply uncertain
- Quantity of Potential Renewables Unclear
  - Example: ignored wave/ocean
- Potential RPS Feedback Effects Ignored:
  - Increased portfolio diversity
  - Reduced regional natural gas consumption
  - Decreased regional wholesale market prices

Updated Results: Base Case

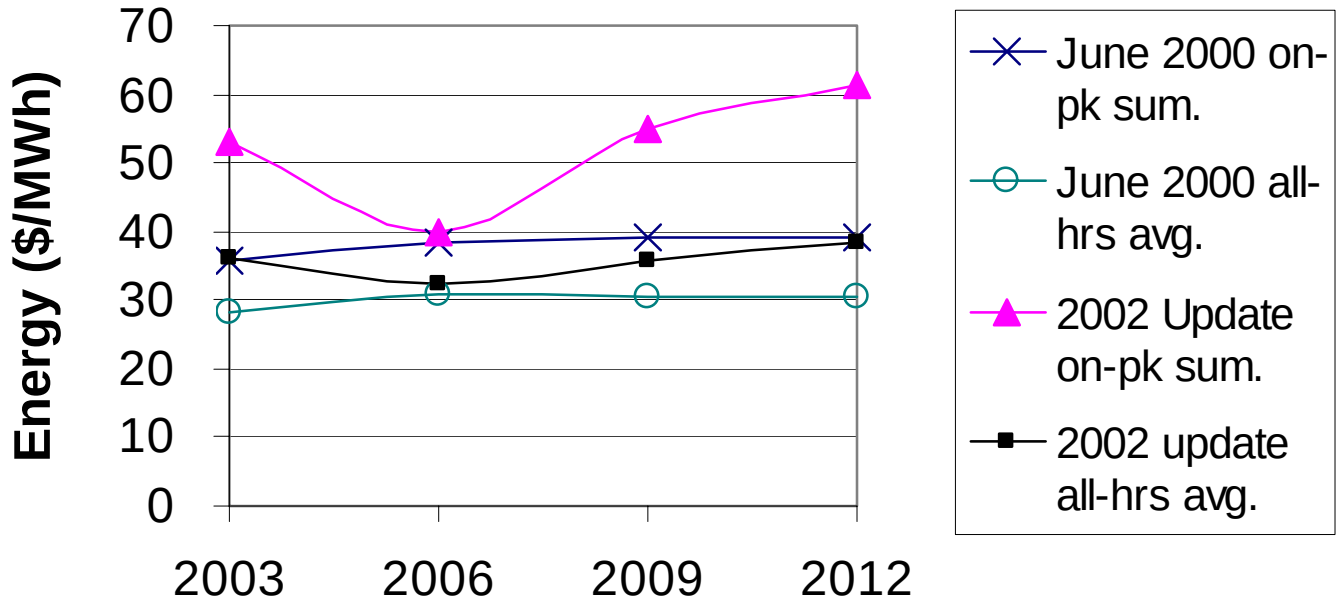
- Key assumptions
  - Reviewed at Nov. 7 session
  - Feedback at meeting, and via written comments, was helpful and taken into account
    - Examples: imports refinement; wind success probability adjustments, market price refinement, financing assumptions, etc.
- Projected results
- Implied supply mix
- Limitations

Key Base Case Assumptions

- NY Imports: $6/MWh (outwheeling); $2/MWh (difference between western NY and NE hub); 0.75 S.F.; 4% losses
- Production Tax Credit: extended through 2006 (wind only)
- '06 Off-shore wind: $1590/MW (~6.2 c/kWh); CF: 39%
- CT RPS: assumed fixed (include SO/DS) & starting over @ 0.5% Class I in'04
- Locational Marginal Pricing: 80% of RET; -$2/MWh
- Wind finance: 45% debt @ 7.8% for 15 yrs (18% ROE)
- Baseload finance: 50% debt @ 7.6% for 12 yrs (15% ROE)
- Green marketing: increases to 417 GWh by 2012
- Biomass Fuel costs: $2/mmBtu ~ $20/green ton

Base Case Key Assumptions – Wholesale Market Price Forecast

Energy in 2000$

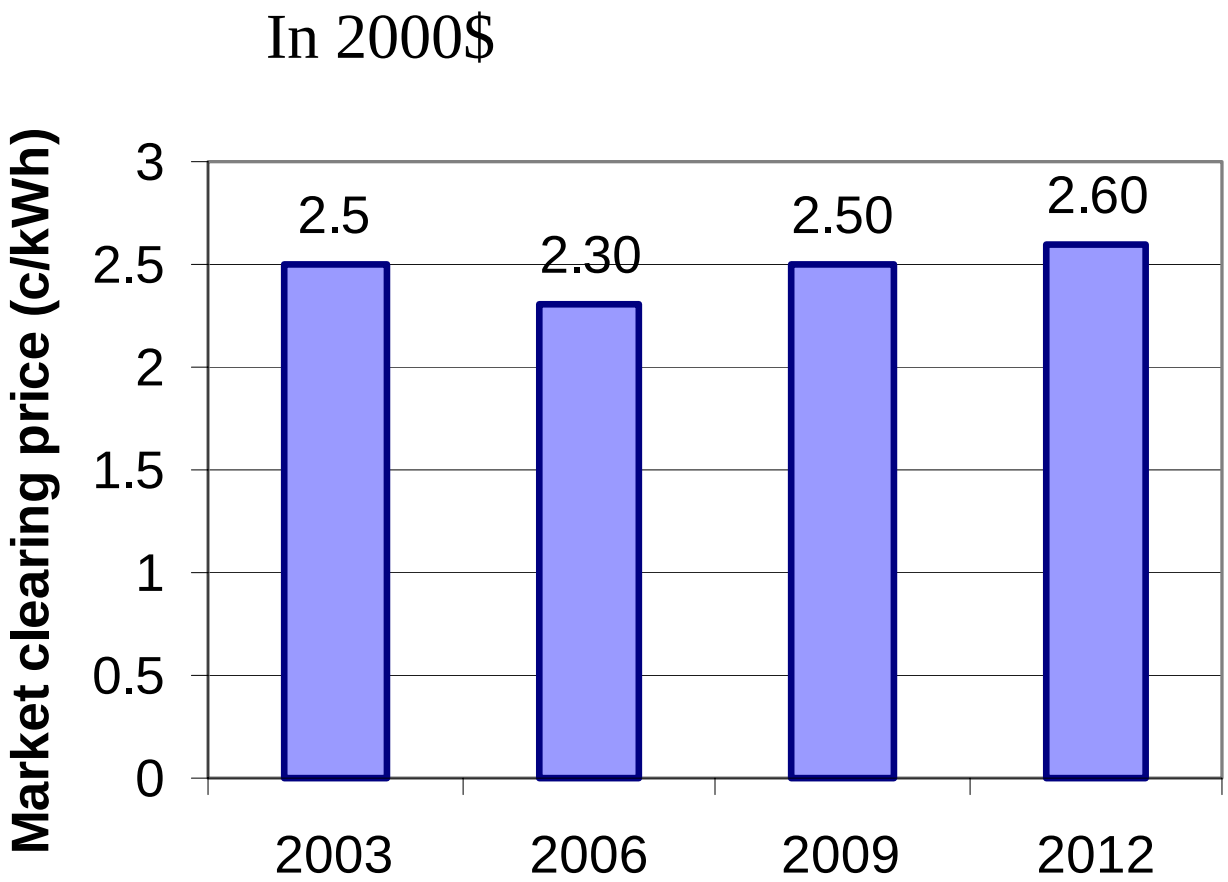


In 2000$	2003	2006	2009	2012
Capacity ($/kW-yr)	15	30	44	44

2003 Cost Projection

- Early compliance + committed projects sufficient for meeting 2003 targets without requiring new construction
- Costs likely to be determined by plants positioned to be "price takers"
- Cost-based analysis cannot capture the interplay between the following factors:
  - Bidding behavior of existing plants
  - Implicit opportunity cost of banking 2003 production for 2004/5
  - Possible exercise of market power bounded by cost of new entry
- For 2003, used 12/02 forward market price to represent market's balancing of these factors

Base Case Results – Certificates Price

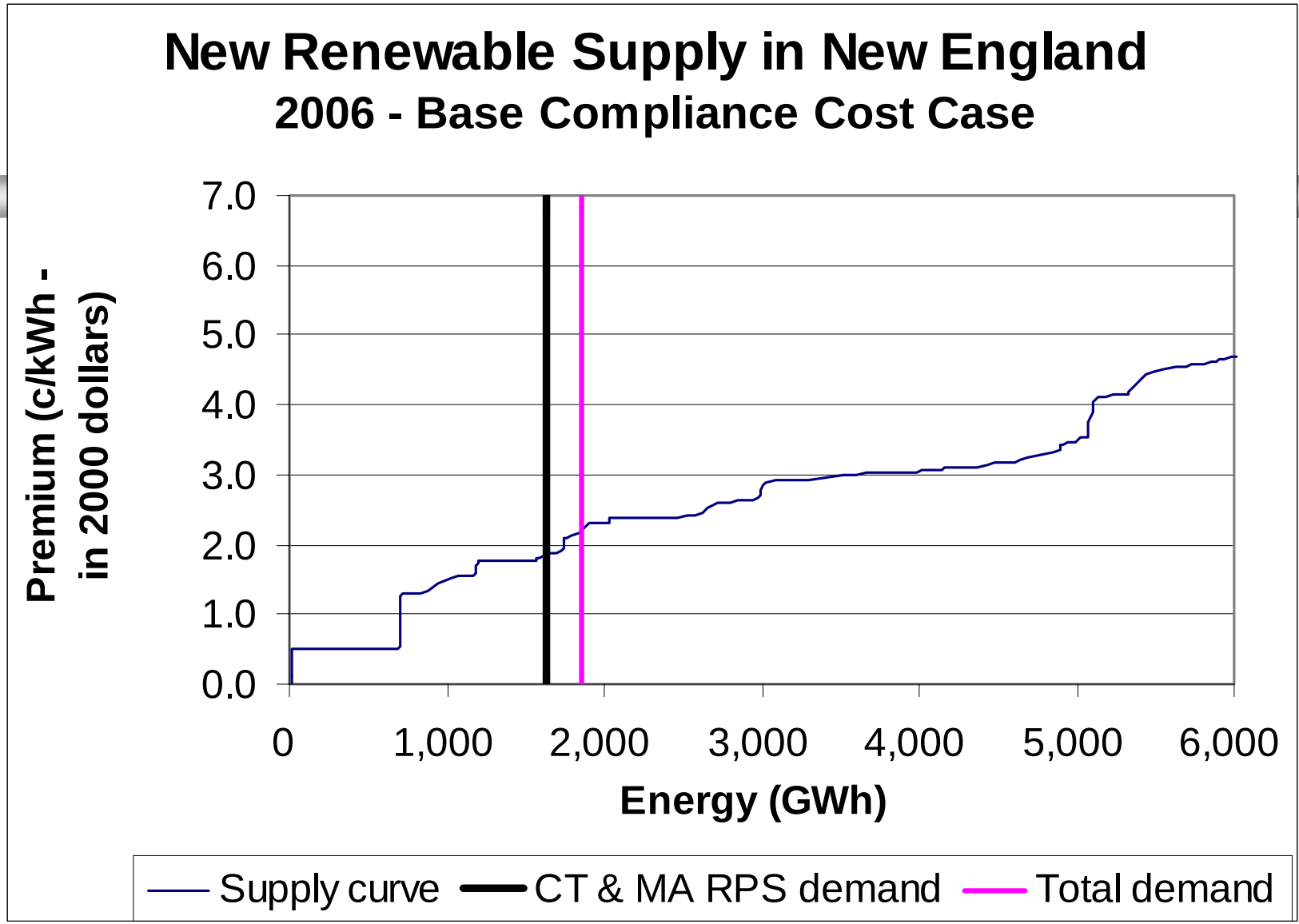


Base Case Results – Implied Supply Mix

		2003	2006	2009	2012
N. Eng.	Biomass large	16%	19%	33%	29%
	Biomass small	0%	0%	0%	1%
	Digester	0%	2%	1%	1%
	Fuel cell	0%	0%	2%	2%
	Behind the meter	0%	0%	1%	1%
	Landfill gas	83%	37%	27%	16%
	PV	0%	0%	0%	0%
	Wind	1%	24%	24%	22%
NY	Digester	0%	4%	2%	1%
	Landfill gas	0%	3%	2%	2%
	Wind	0%	10%	3%	7%
HQ	Wind	0%	0%	5%	18%
	TOTAL GWh	307.0	1,854.3	3,356.6	6,176.3

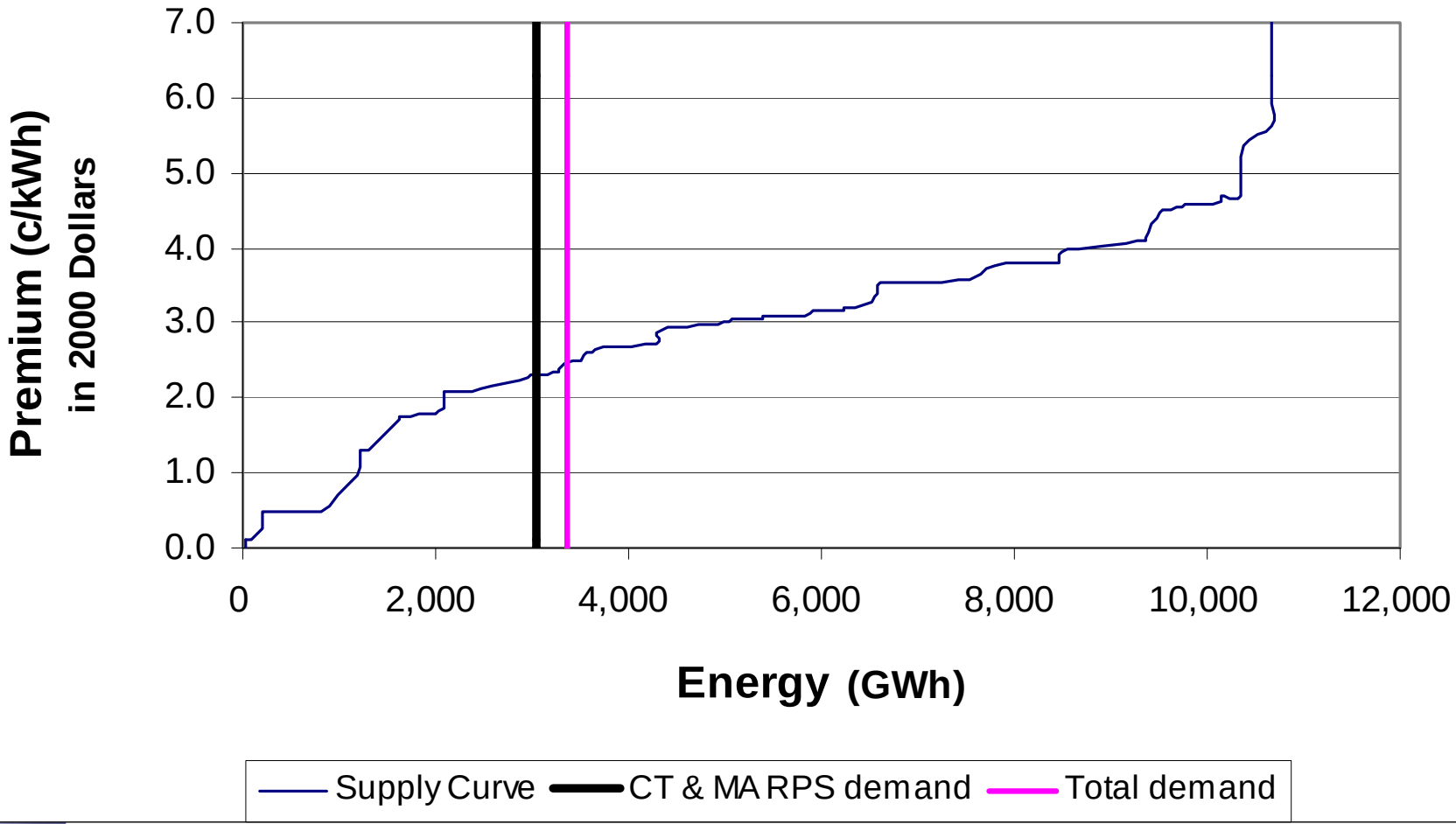
Observations

- Off-shore wind was just off the margin
- Within a few mils, there is a lot at play.
  - On-shore wind
  - Off-shore wind
  - Landfill gas
  - Imports (mostly NY LFG and wind)
  - Biogas co-fired at NGCC


New Renewable Supply in New England
2006 - Base Compliance Cost Case
Premium (c/kWh - in 2000 dollars)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
1,000
2,000
3,000
4,000
5,000
6,000
Energy (GWh)
Supply curve
CT & MA RPS demand
Total demand

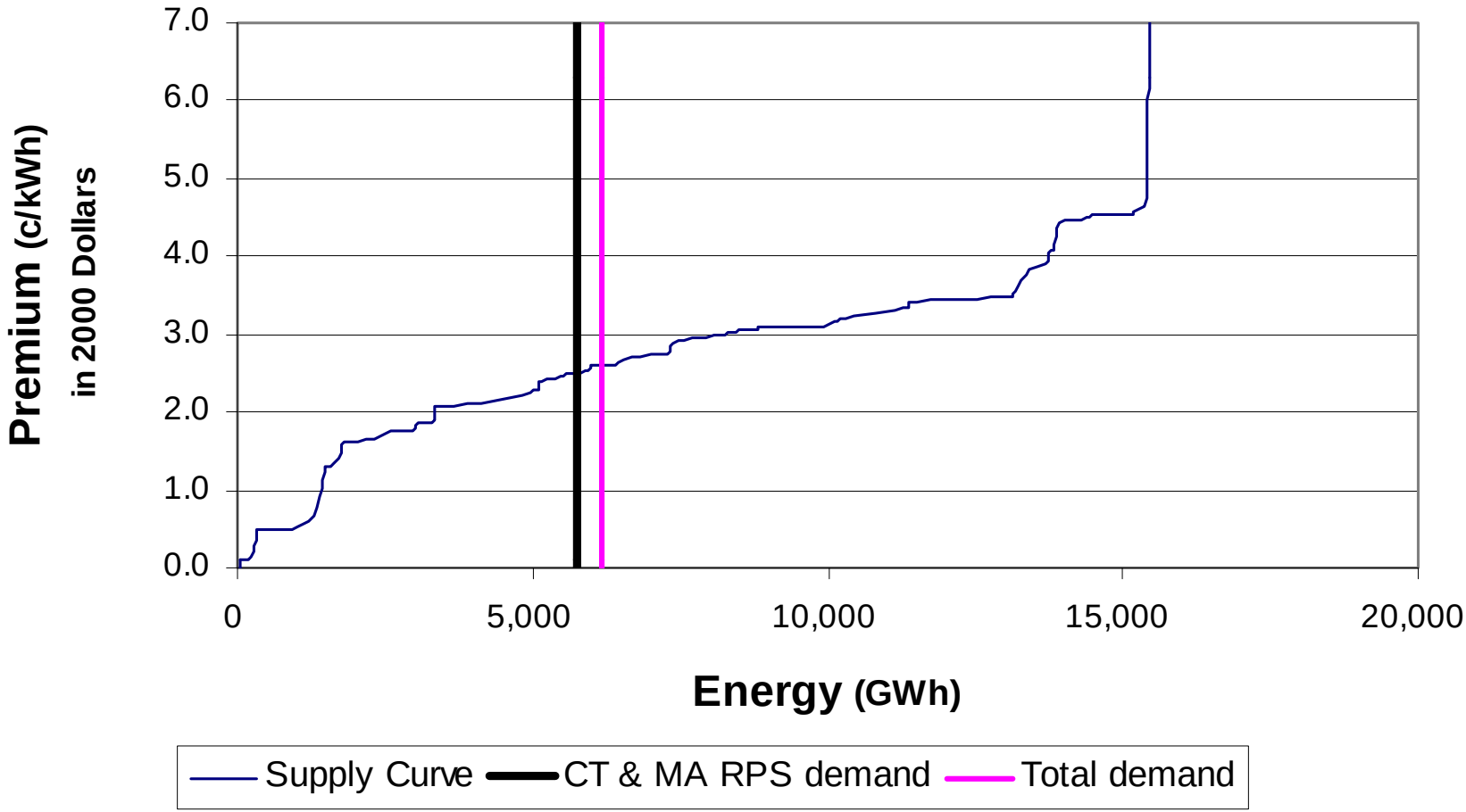
New Renewable Supply in New England

2009 - Base Compliance Cost Case



New Renewable Supply in New England

2012 - Base Compliance Cost Case



Scenarios: High and Low RPS Cost

- Scenario Definitions
- Scenario Results – a broad envelope
- Implications

Scenario Definitions - 1

	Lower Cost to Implement RPS	Base Case	Higher Cost to Implement RPS
NY Imports Scheduling Factor	1	0.75	0.65
NY Import MWh costs	Outwheel to NE: $0/MWh NY to NE LMP: $2/MWh	Outwheel to NE: $6/MWh NY to NE LMP: $2/MWh	Increase by 25%: Outwheel to NE: $7.5/MWh NY to NE LMP: $2.5/MWh
PTC (wind only)	End 2012	Thru 2006	Thru 2003
Off Shore Wind	$1410/kW in 2006 (results in 1c/kWh decrease in 2006)	MW avail (year): 200 MW (’06) 400 MW (’09) 800 MW: (’12) Cap cost: $1671/kW	Dates pushed 3 yrs due to federal siting process: 200 MW (’09) 400 MW (’12)
On-shore wind probability scalar	1.2	1.0	0.8

Scenario Definitions - 2

	Lower Cost to Implement RPS	Base Case	Higher Cost to Implement RPS
Biomass Fuel	$1.50	$2/ Million BTU	$3
Green Marketing	200 GWh	417 GWh in 2012	600 GWh
CT RPS applies to all load	Never	Yes – 0.5% Class I pushed back to '04	same as base
LMP	No derate (i.e. no constraints)	Derates energy income by $2 for 80% of renewables	Derates by $4 for 80% of renewables
Financing	Wind: 13.75% Baseload: 14.95%	Wind: 15% Baseload: 16.2%	Wind: 16.25% Baseload: 17.45%

Base Case Wholesale Market Price Forecast

$/MWh		2003	2006	2009	2012
on-peak	**summer**	53.0	40.0	55.0	61.2
	other	37.7	38.2	39.6	41.4
off-peak	**summer**	34.0	26.8	27.8	29.9
	other	28.0	26.7	27.8	29.3
Capacity price ($/kW-yr)		15.0	30.0	43.8	43.8

Scenario Definitions - 3

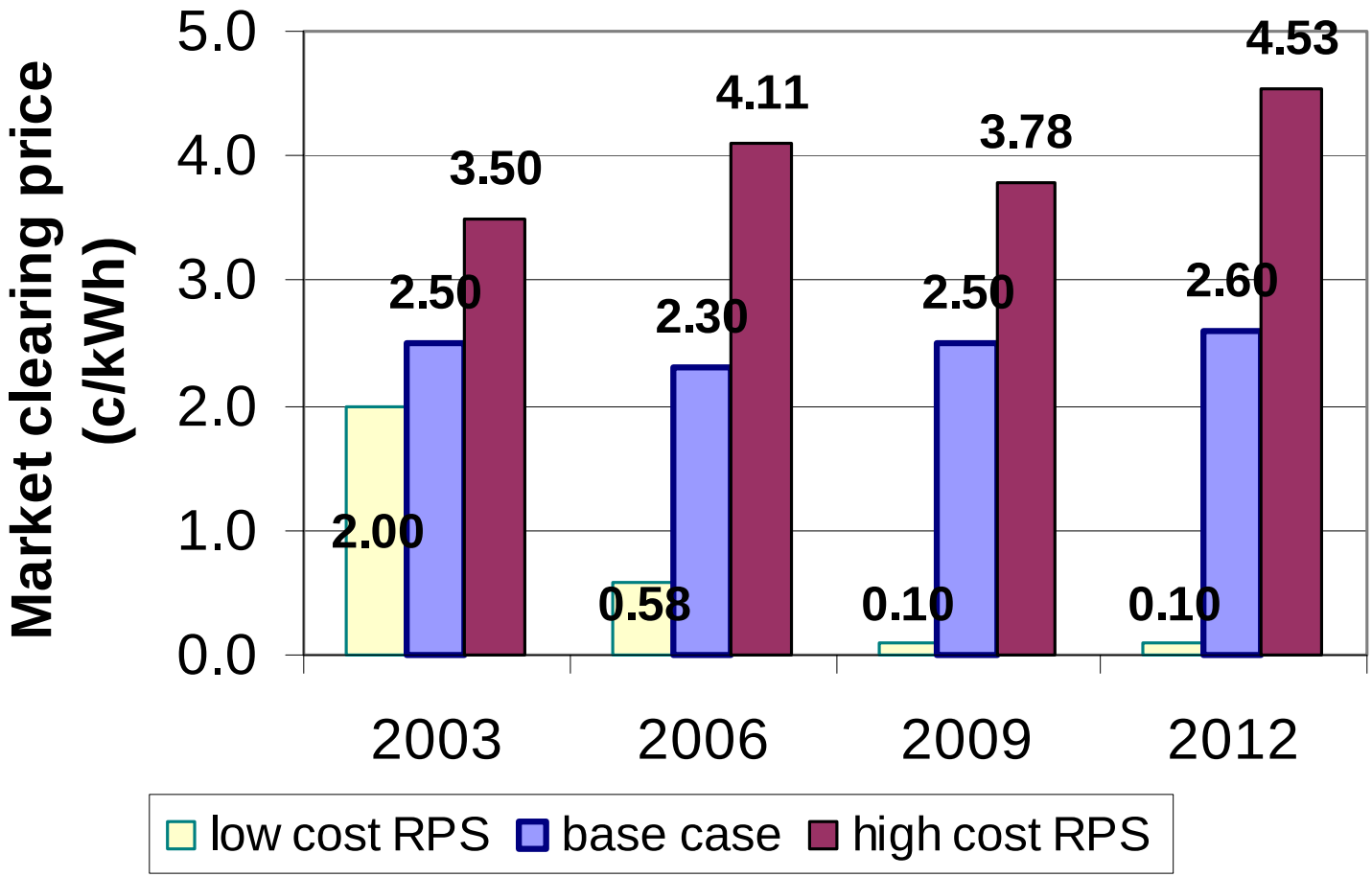
LOW RPS Cost Case

$/MWh		2003	2006	2009	2012
on-peak	**summer**	60.9	46.2	63.2	70.6
	other	43.3	43.9	45.6	47.8
off-peak	**summer**	39.1	30.9	32.0	34.3
	other	32.1	30.6	31.9	33.7
Capacity price ($/kW-yr)		15.0	30.0	43.8	43.8

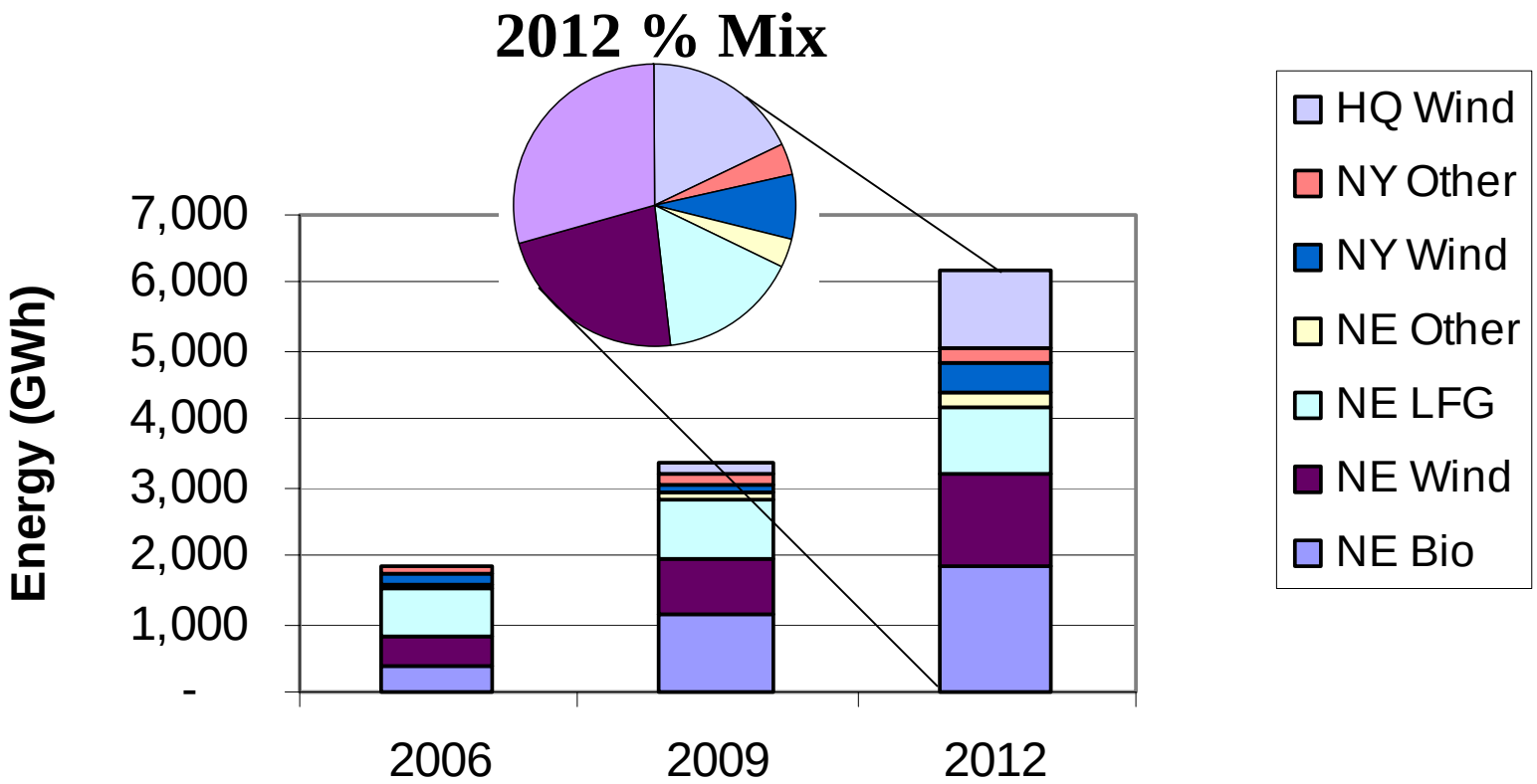
HIGH RPS Cost Case

$/MWh		2003	2006	2009	2012
on-peak	**summer**	45.2	33.9	46.8	51.9
	other	32.1	32.5	33.6	35.0
off-peak	**summer**	28.8	22.9	23.6	25.5
	other	23.9	22.8	23.6	24.9
Capacity price ($/kW-yr)		15.0	30.0	43.8	43.8

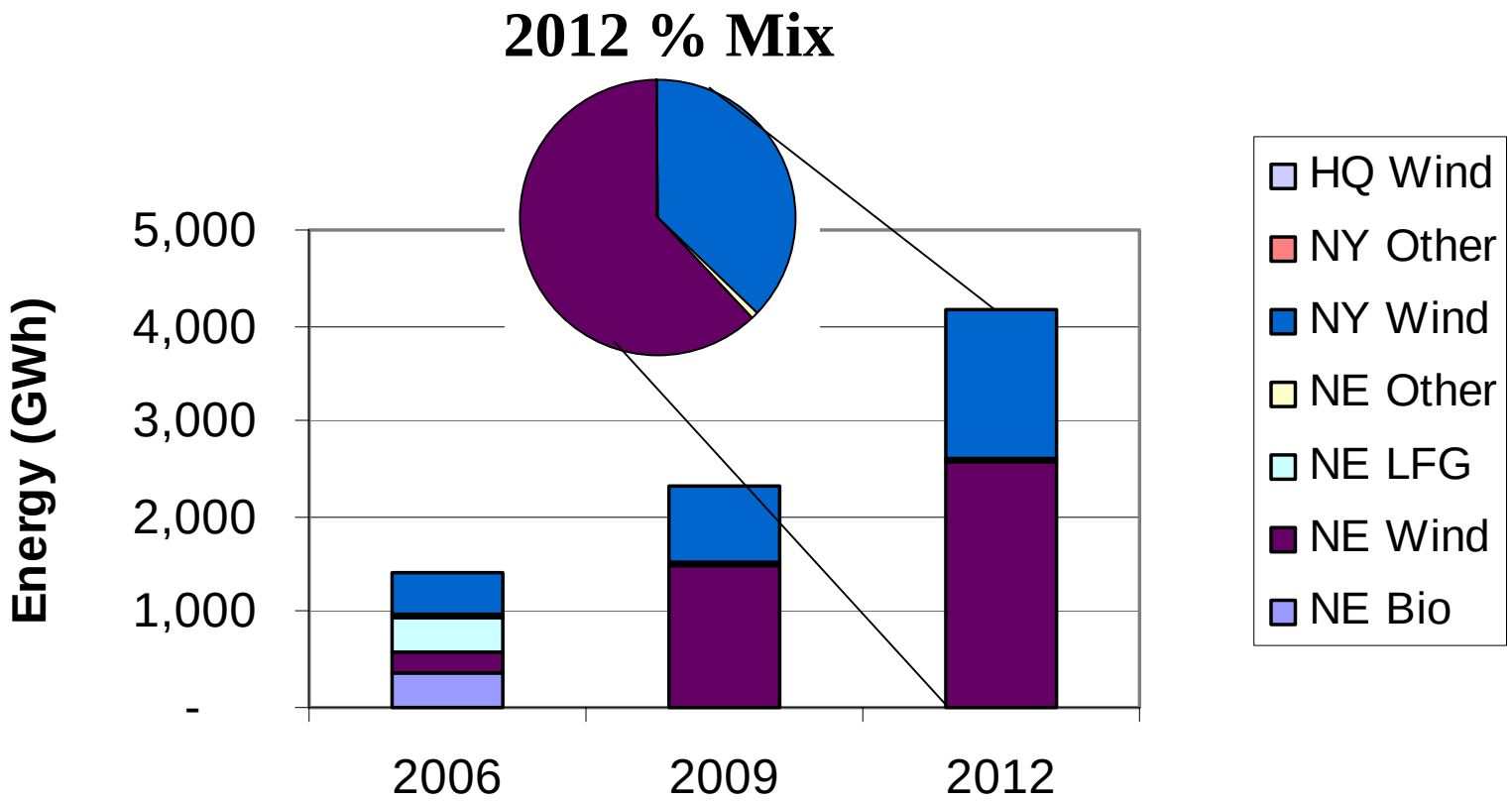
Scenario Results – Certificates Price



Supply Mix Comparison - Base Case

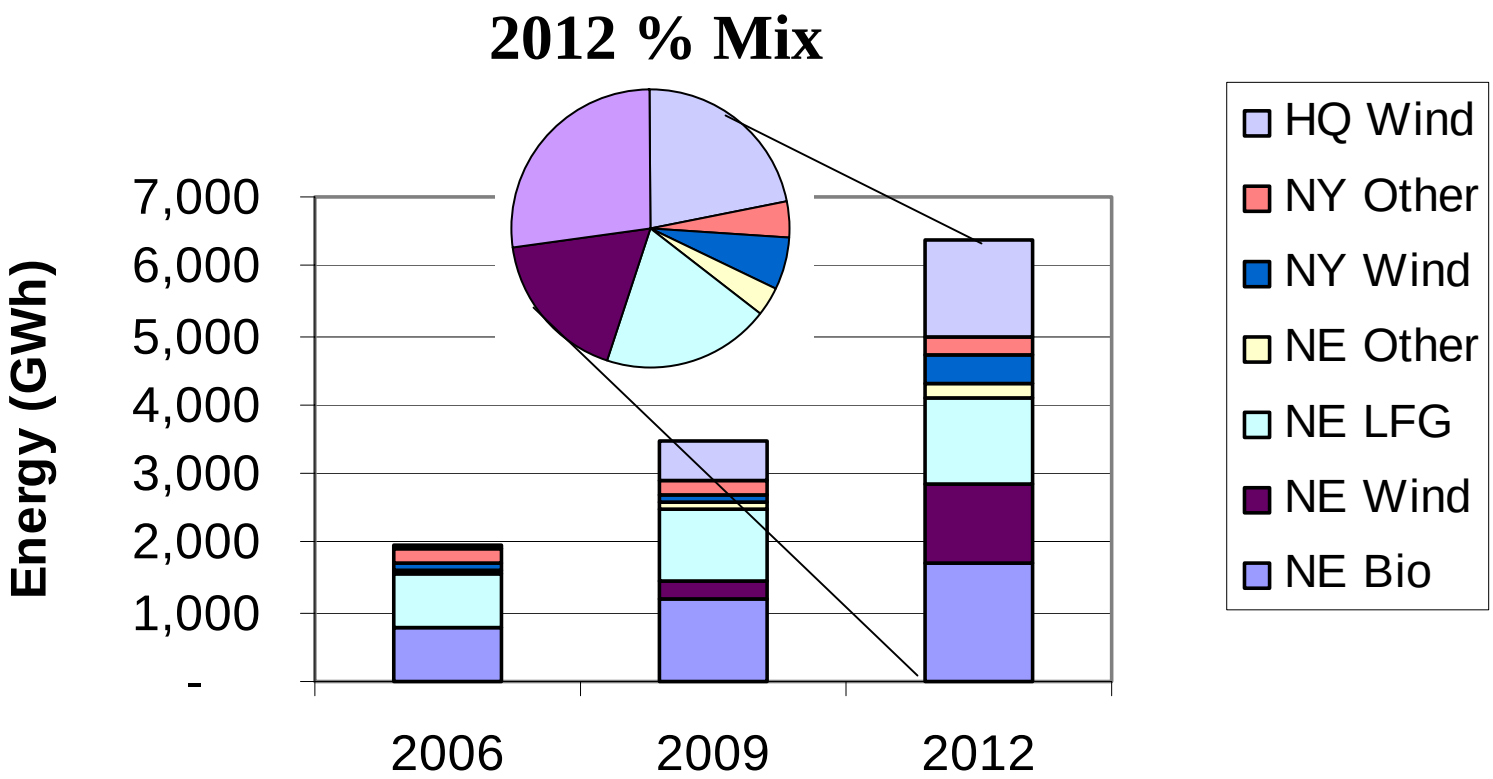


Supply Mix Comparison – Low RPS Cost Case



NE wind: 76% off-shore wind in 2009, 90% in 2012

Supply Mix Comparison – High RPS Cost Case



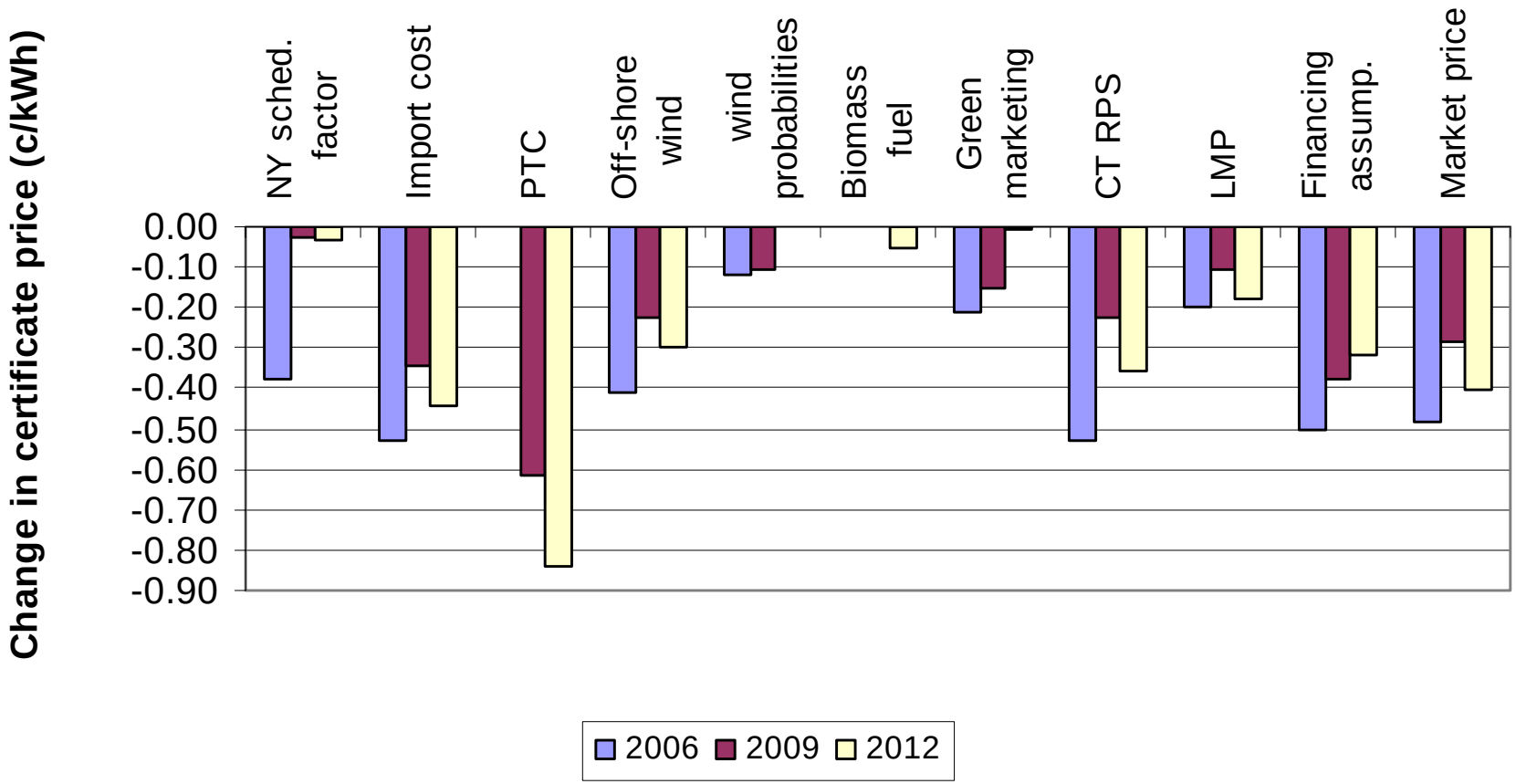
Scenario Implications

- Supply mix
  - diverse in base case,
  - Includes more wind in low cost case and
  - Less wind, more LFG, more imports in high cost case
- The likelihood of all low cost/high cost drivers converging at the same time is unlikely, but possible in the short-term (e.g. California)
- Even in worst case, it appears that there will be enough supply in the long-term
- Potential for NE supply shortage in 2004 will be incentive for eligible existing and new imports

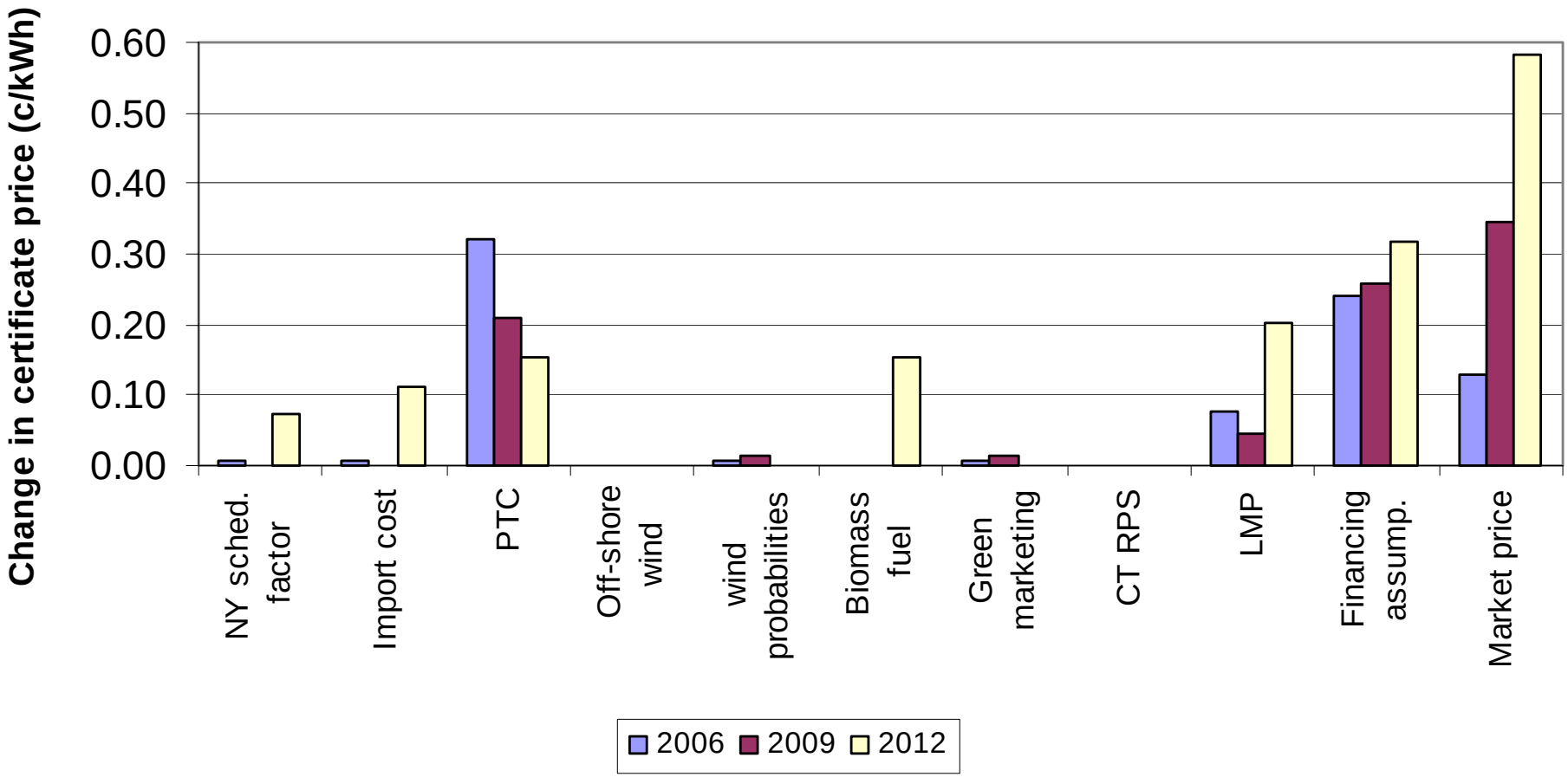
Impacts of Major Cost Drivers

- What assumptions are most important?
- What are their relative contributions?
- Upside and downside risks
  - Symmetric
  - Asymmetric

Relative Impact of Individual Cost Drivers- Low Price Values

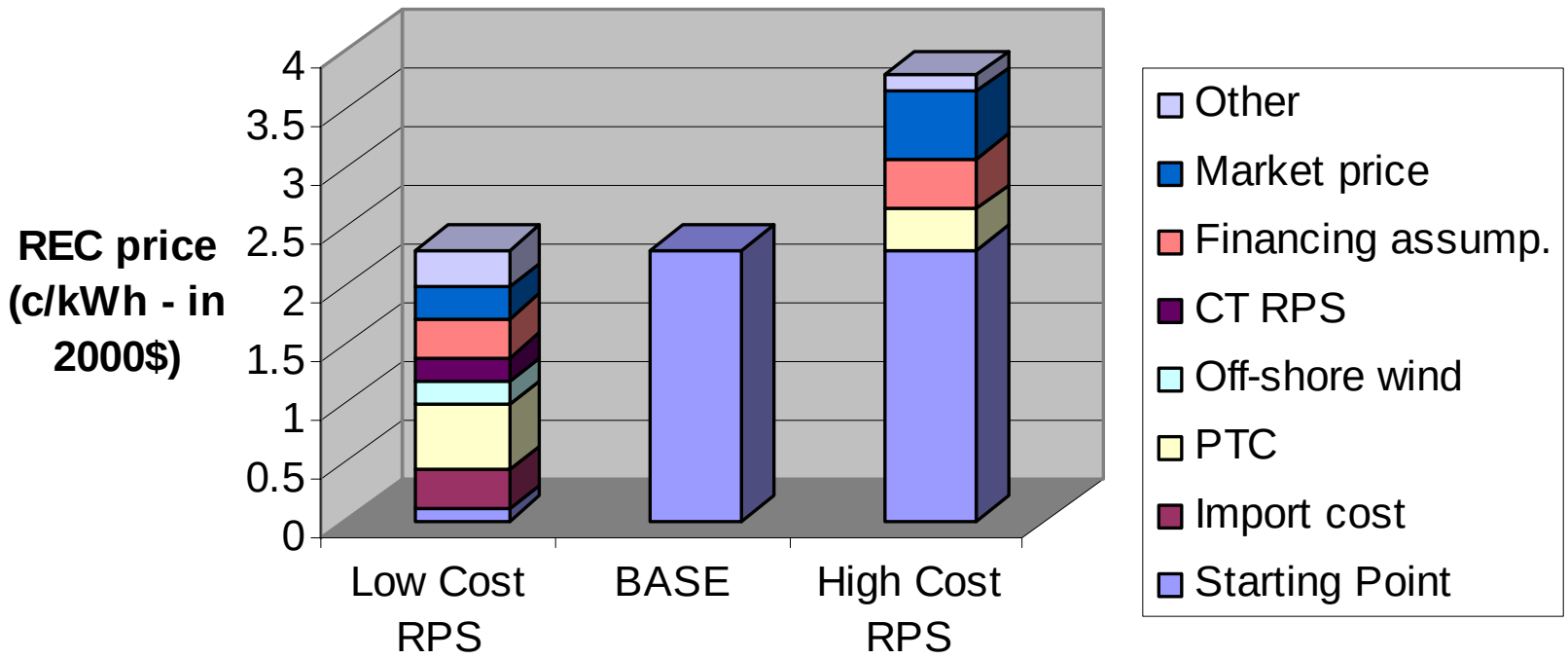


Relative Impact of Individual Cost Drivers- High Price Values



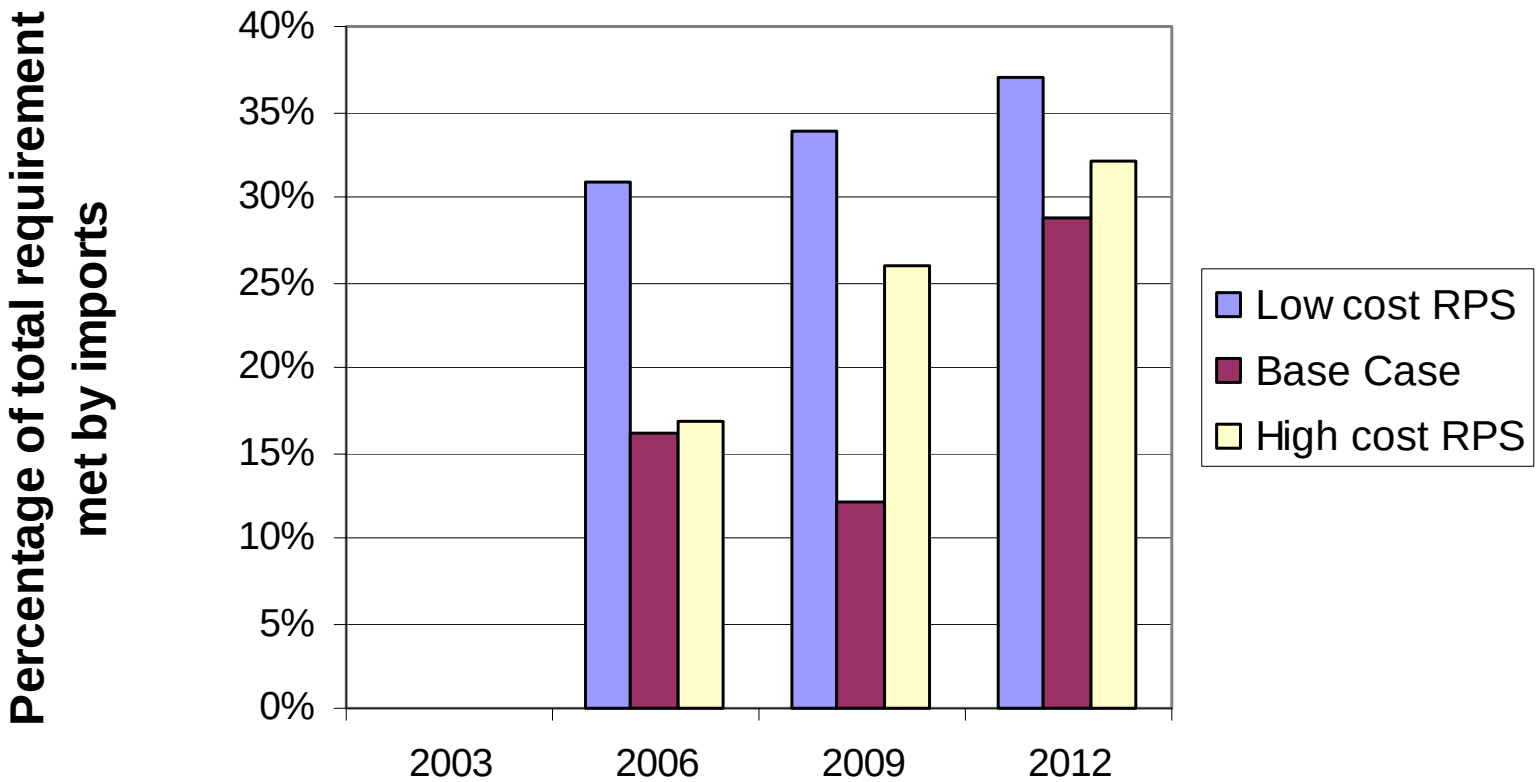
Another Perspective on Sensitivity

In 2009:



The Impact of Imports on the Analysis - 1

- One of the most controversial focal points of analysis



The Impact of Imports on the Analysis - 2

REC price (c/kWh - 2000$)

	Assumptions				
	$/MWh	*SF*	**2006**	**2009**	**2012**
Base + Low cost imports	*2**	*1*	1.77	2.09	2.11
Base case	*8**	*0.75*	2.30	2.50	2.60
Base + High cost imports	*10***	*0.65*	2.32	2.50	2.71

* Includes $2/MWh differential between NYISO NEPOOL bus and NEPOOL hub

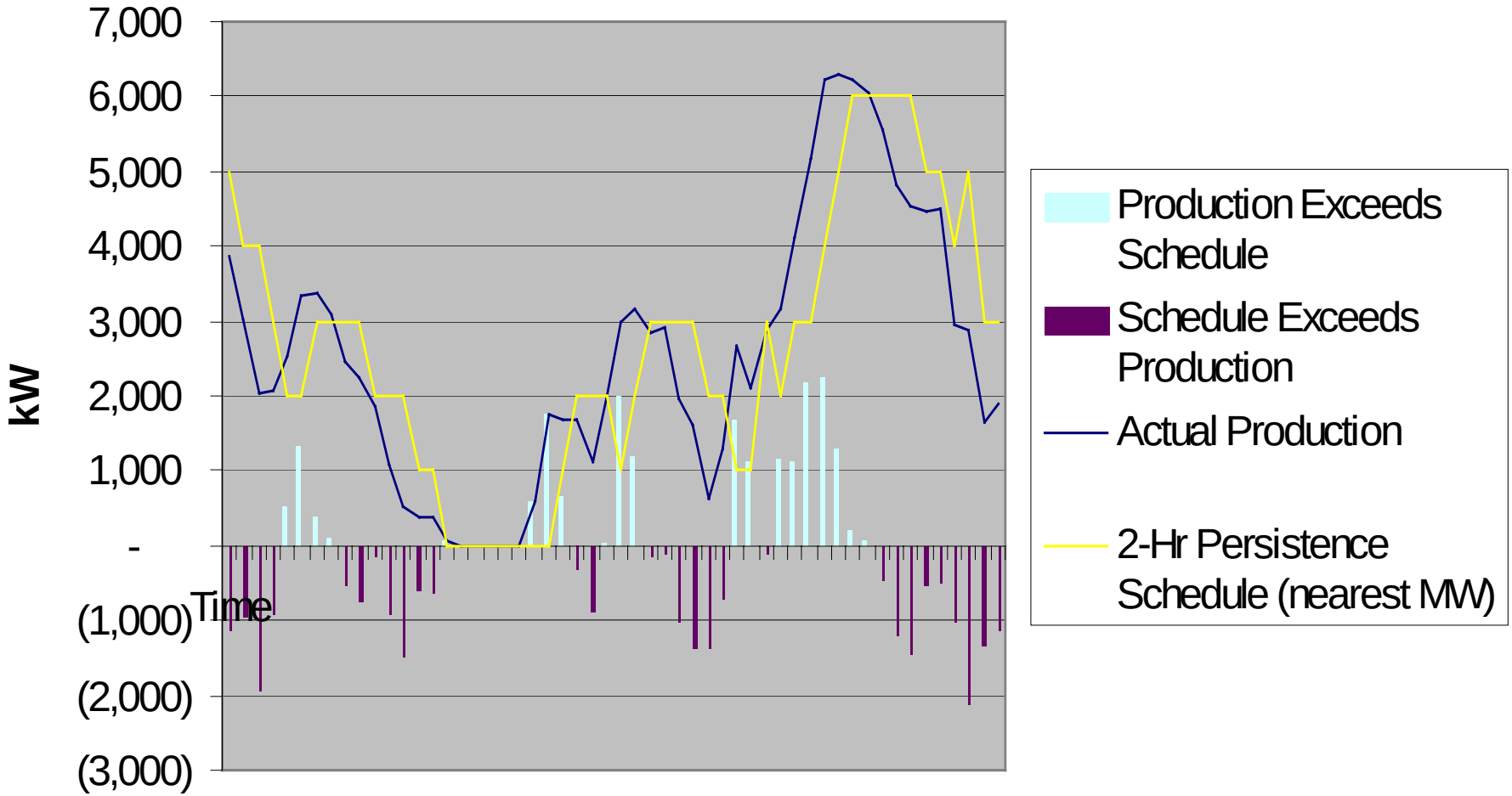
** Includes $2.50/MWh differential between NYISO NEPOOL bus and NEPOOL hub

Import Cost Analysis - 3

- We modeled the cost of imports, see demo

	Today's Market Rules ($/MWh)	If FERC SMD reduces or eliminates seams ($/MWh)
NE Geographic + Strict Delivery (hourly)	$11.50-12.50 wind ~$8.00 baseload	$5.50 – 8.00 wind $2.00-3.50 baseload
NE Geographic + Relaxed Delivery (monthly)	~$8.00	$2.00 – 3.50
NE + NY Geographic + Strict Delivery (hourly)	$0.00 – 2.00	$0.00 – 2.00

Example of 2-Hour Persistence Forecasting for Small Wind Plant in NY



Conclusions - 1

- **Since last time, many moving parts in offsetting directions:**
  - **biomass playing a smaller role due to tighter eligibility;**
  - **import cost barriers higher than assumed last time, but not high enough to keep imports from contributing and mitigating costs;**
  - **CT RPS loophole takes a lot of pressure off;**
  - **Market prices have increased**
  - **Challenging environment for financing**
  - **Less lead time for projects, but 2003 looks to be in good shape with early compliance.**
- **Little long-term reliance on ACM**

➔ **Amazingly, base case bottom-line hasn't changed that much!**

(yes, it surprised us too)

Conclusions - 2

- **Sensitivity to exogenous variables is large, but +/- 1.0-1.5 c/kWh captures most of the reasonable variation**
- **Reminder: @ 2.5 c/kWh for every 1% of RPS obligation yields 1/40 c/kWh (or 0.25 mils/kWh) retail rate impact**

END OF PRESENTATION